0694

PB 200 873

CALIFORNIA
DEPARTMENT OF AGRICULTURE

A SURVEY AND ASSESSMENT OF AIR POLLUTION DAMAGE TO CALIFORNIA VEGETATION IN 1970

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Springfield, Va. 22151

JUNE, 1971

PB 200 873

STANDARD TITLE PAGE FOR TECHNICAL REPORTS	1. Report No. APTD-0694	2. Govt. Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle
A SURVEY AND ASSESSMENT OF AIR POLLUTION DAMAGE TO CALIFORNIA VEGETATION IN 1970

5. Report Date
June, 1971

6. Performing Organization Code

7. Author(s)
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8. Performing Organization Rept. No.

9. Performing Organization Name and Address
California Department of Agriculture
Bureau of Plant Pathology
1220 N Street
Sacramento, California 95814

10. Project/Task/Work Unit No.

11. Contract/Grant No.
CPA 70-91

12. Sponsoring Agency Name and Address
Air Pollution Control Office
Environmental Protection Agency
Post Office Box 12055
Research Triangle Park, N. C. 27711

13. Type of Report & Period Covered

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstracts
A state wide survey was made in California to determine the areas of occurrence of plant injury due to air pollutants, and to assess the damage to agricultural plant crops. On the basis of observations and evaluations made by agricultural specialists California's 1970 crop losses due to air pollutants were estimated to be approximately $25,690,680. The losses were confined to 15 of the 58 counties in the state. The monetary loss figure does not include losses attributed to reduction in crop yield as a result of invisible damage with the exception of citrus and grapes.

17. Key Words and Document Analysis. (a). Descriptors
Air pollution
Plants (botany)
Losses
Costs
Fruit crops
Forest trees
Flowers
Vegetable crops
Smog

17b. Identifiers/Open-Ended Terms
Air pollution effects (plants)
California

17c. COSATI Field/Group 13/B, 2/B, 2/D

18. Distribution Statement	19. Security Class (This Report)	21. No. of Pages
Unlimited	UNCLASSIFIED	52
	20. Security Class. (This Page) UNCLASSIFIED	22. Price

FORM NBS-867(1-70)

DISCLAIMER

This report was furnished to the Air Pollution Control Office by
California Department of Agriculture
Bureau of Plant Pathology
1220 N Street
Sacramento, California 95814
in fulfillment of Contract No. CPA 70-91

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by

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June, 1971

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ACKNOWLEDGEMENTS

The work reported here was performed pursuant to Contract No. CPA 70-91 with the Air Pollution Control Office, Environmental Protection Agency, and in part by the California Department of Agriculture and cooperating County Departments of Agriculture.

Grateful acknowledgement is made to the many members of County Agricultural Commissioner's staffs who made field observations and provided most of the data used in this report. Also, I thank members of the Statewide Air Research Center, University of California, Riverside, and California Air Resources Board, Sacramento, who gave valuable advice and assistance during the project.

To the members of the Bureau of Plant Pathology, whose help, patience, and forbearance during the preparation of this report was the final important ingredient, go my deepest thanks and sincere appreciation.

ABSTRACT

The California Department of Agriculture in cooperation with county agricultural commissioners made a statewide survey in 1970 to determine areas of occurrence of plant injury due to air pollutants, and to assess the damage to agricultural plant crops. Having some prior knowledge of the distribution of air pollutants efforts were concentrated in areas with known histories of air pollution problems. On the basis of observations and evaluations made by agricultural specialists, California's 1970 crop losses due to air pollutants were estimated to be approximately $25,690,680. These losses were confined to 15 of the 58 counties in the state. Losses to citrus plantings in the Los Angeles Basin accounted for $19,553,400 of the total monetary losses. Ventura County, with a loss of $10,723,590, experienced the greatest economic crop loss for any one county.

The monetary loss figure does not include losses attributed to reduction in crop yield as a result of invisible damage with the exception of citrus and grapes. Monetary losses to native vegetation including forests or to landscape plantings also were not included.

On-the-spot observations made by trained agricultural specialists provided 450 reports, 359 of which recorded plant injury caused by air pollution. Plant injury was observed in 22 counties.

Photochemical smog accounted for most of the economic losses. Analysis of the reports showed six pollutants to be involved and accounted for the following percentages of plant injury: ozone 50%, PANs 18%, fluorides 15%, ethylene 14%, sulfur dioxide 2%, and particulates 1%.

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INTRODUCTION

California continued to be the nation's number one farm state in 1970 for the 23rd consecutive year. With gross cash receipts from farm marketings totalling $4.49 billion, it outranked its nearest competitor, Iowa, by $600 million (1). Some 200 crops are recognized in California, including seeds, flowers and ornamentals. Most crops grown anywhere in the United States also are grown somewhere in California, the only notable exceptions being tobacco and soybeans. California leads the nation in the production of 48 commercial crop and livestock commodities. No one crop dominates the State's farm economy. The diversity of California agriculture is illustrated by the fact that most crops individually account for less than 2% of the State's total gross farm income (1). With this diversity of crops on approximately 37 million acres, California produces about 25% of the nation's food.

Air pollution injury to California agriculture first appeared in the Los Angeles area in the early 1940's, and by 1947, when the Los Angeles Air Pollution Control District was created, agricultural damage occurred in a triangle from Santa Monica to El Monte to Dominguez (2). By 1950 the area of agricultural damage had expanded to San Juan Capistrano in the south, and to Riverside in the east. Air pollution injury to vegetation was also found in the San Francisco Bay area for the first time in 1950 (3). By 1957 air pollution injury was found in the San Joaquin Valley near Bakersfield in the south and around Stockton and Tracy in the north. The following year injury was found around Fresno and in the Sacramento-San Joaquin River Delta (2).

Literature Cited

(1) California Dept. Agric. 1971. California Agriculture 1970: a report on California's principal crop and livestock commodities. Calif. Crop and Livestock Reporting Service, Sacramento (multilith) 16 p.

(2) Middleton, J. T. 1959. Impact of air pollution upon California Agriculture, U. S. Congressional Record (May 5) p. A3716-A3717.

(3) Middleton, J. T., E. F. Darley, and R. F. Brewer. 1958. Damage to vegetation from polluted atmospheres. J. Air. Pollut. Cont. Assoc. 8:9-15.

PREVIOUS SURVEYS AND ESTIMATES

The first known instance of plant injury caused by air pollution in California was in 1942 when a Temple City nurseryman in the San Gabriel Valley east of Los Angeles noticed a glazing on the under surface of the leaves of petunia plants (8). The following year a grower in nearby South El Monte noticed a discoloration of lettuce, endive, and celery. Complaints from his marketing outlets forced him to change to other crops which were not affected by the discoloration. In 1944, growers in the Dominguez area, near San Pedro, noticed an unusual condition affecting their crops, and after the problem was investigated by the University of California Citrus Experiment Station at Riverside (5), it was identified as "smog" injury. Since that time the problem has grown steadily worse. Middleton et al. (5) reported "unusual amounts of damage" from air pollution in 1947 and 1948. In 1949 these authors found that entire fields of spinach were abandoned because of severe leaf scorching which rendered the crop unmarketable. Yields of alfalfa in some areas of Los Angeles County were reduced 50% because of defoliation and some cuttings for hay were abandoned because damage reduced its market value by increasing the stem-to-leaf ratio.

Today the San Gabriel Valley is considered to be one of the "smoggiest" parts of Los Angeles County. Heuer (3) has observed the abandonment or relocation of the production of several crops in that area. Zinnia seed production in the El Monte area and spinach in the Puente-Bassett area were the first crops to be abandoned because of air pollution.

Head and Romaine lettuce were discontinued in favor of the red-leaved varieties. Celery production in the area has declined, in part from air pollution damage, and in part from urbanization of the growing areas, while orchid and chrysanthemum houses have been moved to coastal areas.

Turnip greens are now grown in coastal areas, along with parsnips, table beets, and parsley, which also have been relocated to escape air pollution effects in the San Gabriel area.

Tomatoes and string beans are no longer grown in the San Gabriel Valley, and alfalfa acreage in the Los Angeles Basin is sharply reduced. Cucumber and canteloupe production is now moving out of east Los Angeles because it is suspected that fruit set is reduced in these crops by air pollution.

Nurseries are finding it impossible to root Euonymus cuttings in smoggy areas of the county; one more victim of air pollution.

All of these observations (3) need further study and documentation, but the situation is nevertheless, serious for agriculture because growers in the county are now severely limited in their choice of crops. Only a few things remain that can be grown in the San Gabriel Valley, which once had the richest and most diversified agriculture in a state itself unique for its crop diversity.

The first statewide survey of air pollution "damage" to vegetation was made on an experimental basis by the University of California Extension Service in 1955 (6). Specialists in agriculture were trained as "crop survey reporters" to provide the reports of air pollution injury. Plant injury was recorded in 12 of 51 counties that reported, but no loss estimates were made of the damage.

Estimates of losses due to air pollution damage to plant crops in California vary with the area, the pollutants, and the crop plants involved. Middleton et al. in 1950 (5) estimated a loss of $479,495 to 11 selected crops in Los Angeles County alone during 1949. Heuer (3) has estimated losses due to "smog damage" to agricultural crops in the same county as $2,515,000, $4,048,000, $2,536,000, $2,358,000, and $2,855,400 for the years of 1966, 1967, 1968, 1969, and 1970 respectively.

Middleton in 1961 (4) placed the estimated visible damage to field and vegetable crops of California at approximately $8,000,000. In a 1965 report of the California Department of Public Health (1), the losses to agronomic species of California were estimated to be $132 million a year. Calvert (2) estimated in 1968 that the cost of "plant damage by photochemical smog" in California amounted to $248 million. This estimate included plant damage losses to vegetables, citrus (Southern California), ornamentals, and trees of the Lake Arrowhead region. Millecan (7) estimated an annual loss in 1969 of $44.5 million for California agricultural crops, not including losses to forests or ornamental vegetation. Benedict (9) in 1970 estimated a present loss of $18.9 million for agricultural crops, nursery stock, and forest products in 22 selected counties of California.

The historical evidence of air pollution damage to vegetation throughout California is substantial in some areas and scanty in others, thus the need for an intensive statewide survey to define the problem.

Literature Cited

(1) California Department of Public Health. 1965. California Waste Management Study. Report 3056.

(2) Calvert, S. 1968. Statement for the public hearing of Department of Health, Education, and Welfare, Office of the Secretary on Motor Vehicle Pollution Control Standards.

(3) Heuer, J. J. 1971. Smog damage to crops in Los Angeles County (unpublished). Agricultural Services Division, County of Los Angeles, California.

(4) Middleton, J. T. 1961. Photochemical air pollution to plants. Ann. Rev. Plant Physiol. 12:431-448.

(5) Middleton J. T., J. B. Kendrick, Jr., and H. W. Schwalm. 1950. Injury to herbaceous plants by smog or air pollution. Plant Dis. Reptr. 34:245-252.

(6) Middleton, J. T., and A. O. Paulus. 1956. The identification and distribution of air pollutants through plant response. Arch. Indust. Health. 14:526-532.

(7) Millecan, A. A. 1970. Air pollution crop losses in 1969. (Unpublished).

(8) Noble, W. M. 1965. Smog damage to plants. Lasca Leaves. 15:2-4.

(9) Stanford Research Institute. 1970. Annual Report: economic impact of air pollutants on plants. Vol. II. Stanf. Res. Inst., Menlo Park, Calif. (multilith) 558 p.

PRESENT SURVEY

This survey on air pollution injury to vegetation in California was carried on cooperatively by the California Department of Agriculture and County Agricultural Commissioners. A plant pathologist of the Department with eight years of experience in the detection and diagnosis of air pollution damage to plants in California was appointed survey leader to direct and coordinate the work with agricultural specialists who were permanent staff members of Agricultural Commissioner's offices. These specialists observed and reported the information of air pollution damage along with their normal assignments in conducting regulatory agriculture work.

Special training on air pollutants and their effects upon vegetation was provided for the participating agricultural specialists. A three day training program at Riverside in July, 1970, was presented cooperatively by the National Air Pollution Control Administration, the Statewide Air Pollution Research Center of the University of California, Riverside, and the California Department of Agriculture. The program included talks, illustrated with slides, by nationally recognized air pollution experts. Guidelines and informational handouts (1,3,5) were given relative to the recognition, evaluation and reporting of air pollution injury and/or damage to vegetation. Seventy agricultural specialists representing 19 counties attended the program. In addition to this three day training program, the survey leader presented six training sessions for 125 agricultural specialists in specific counties requesting assistance. An additional 21 conferences with the county specialists were held to provide

individual training on the recognition and evaluation of air pollution injury and on the making of plant injury reports.

Fifty-three of California's 58 counties have Agricultural Commissioners and staffs of agricultural specialists. Specialists in 20 of the counties were active in making observations for air pollution plant injury. These 20 participating counties essentially coincide with those counties where 63 air monitoring stations are operated by the California Air Resources Board and local cooperating agencies (see Fig. 4). These monitoring stations have been located so as to obtain measured information on contaminants in the ambient air over California cities.

The survey leader and two part-time assistants participated in the active counties but additionally they were responsible for obtaining survey information in the remainder of the State. The project was initiated in June, thus most of the survey information on injury was gathered from June through December 1970. Some data, particularly in Los Angeles County, were gathered prior to June. Plant injury reported by nurseries (see Table 4) also did not necessarily occur during the June-December period.

The results of the survey are based primarily upon individual observations made principally by the agricultural specialists of the participating counties. Each observation at a specific location was recorded on a standardized reporting form (see Fig. 3) and constituted a "report." A report included observations of injury and/or damage to one of several plant species at one location. The observations also provided information of "no injury" or types of injury that did not result in monetary losses. Negative reports for injury could have included observations of non-susceptible plants or of susceptible plants which had not been sufficiently

exposed to pollutants to be injured. A total of 450 observation reports was received, 359 of which recorded plant injury caused by air pollution. Plant injury was observed in 22 counties, and monetary losses were computed in 15 of the counties (Table 2). Thirty-six counties were found free of plant injury due to air pollutants. Eighty-two plant species were observed to show injury from air pollutants (Table 1). Forty-two of these were agronomic species which were involved in the assessment of crop losses.

Annual surveys of air pollution plant injury and damage have been made in Los Angeles County by the Agricultural Commissioner since 1966. With this extended experience, the Los Angeles County agricultural specialists have developed a high degree of proficiency in the recognition and evaluation of plant injury. All data relative to Los Angeles County which are included in this report have been adapted from Los Angeles County's 1970 survey report (4).

The survey leader of the Department has analyzed and interpreted the data of reports and takes the responsibility for the interpretation and projection of that data contained in this survey report.

The geographic features and seasonal meteorological conditions of California and the location of high population centers greatly influences the occurrence of air pollution damage to agriculture. In order that air pollution might be more rationally dealt with, the California Air Resources Board divided the State into eleven air basins (2). These basins were established as areas having similar metorological and geographical conditions but defining the areas with due consideration to existing political boundaries (see Fig. 1). During the course of this

survey work it was noted that these officially designated air basins did not necessarily conform to "natural" occurring basins. Nineteen natural air basins were recognized to exist where plant injury occurs or where there is a potential for its occurrence with possible future changes in population and industry patterns (see Fig. 2). Plant injury or damage observed during the survey was attributed to six pollutants: ethylene, fluorides, ozone, PAN, particulates, and sulfur dioxide. Ozone and the PANs (peroxyacyl nitrates), both products of atmospheric photochemical reactions between hydrocarbons and nitrogen oxides, were the most widespread toxicants and were responsible for most of the plant injury and/or damage. Analysis of the reports showed the six pollutants to be involved with the following percentages of plant injury: ozone 50%, PANs 18%, fluorides 15%, ethylene 14%, sulfur dioxide 2% and particulates 1%.

Ozone and PAN were most prevalent in Los Angeles and adjoing counties which make up the Los Angeles air basin. Plant injury resulting from the fluorides is rather localized, mostly associated with the manufacture of bricks, ceramics and steel. For the most part these fluoride-producing industries are located in areas where there is little agriculture. Ethylene plant injury was essentially associated with the cut-flower trade where plants are maintained in heated glasshouses. Plant injury from sulfur dioxide is very localized as most industrial plant sources have undertaken corrective measures to reduce emmissions of this pollutant. Lime particulates were reported to cover plants and damaged the animal food value of forage plants in one county.

TABLE 1. SUMMARY OF PLANTS FOUND AFFECTED BY AIR POLLUTANTS DURING SURVEY*

PLANT	POLLUTANT
Alfalfa *Medicago sativa* L.	O_3, PAN
Apricot *Prunus armeniaca* L.	F
Ash *Fraxinus* spp.	F
Aster *Aster* spp.	PAN
Apple *Malus sylvestris* Mill.	O_3
Avocado *Persea gratissima* Gaertn.	O_3
Azalea *Rhododendron* spp.	O_3, SO_2
Barley *Hordeum sativa* Jess.	PAN
Bean *Phaseolus vulgaris* L.	F, O_3
Bean, lima *Phaseolus limensis* Macf.	O_3
Beet, garden *Beta vulgaris* L.	PAN
Bermuda grass *Cynodon dactylon* (L) Pers.	PAN
Bottlebrush *Callistemon* sp.	O_3
Boxelder *Acer negundo* L. ssp. *Californicum* (T. & G.) Wesmael	O_3
Calceolaria *Calceolaria* sp.	O_3
Carnation *Dianthus caryophyllus* L.	E, O_3, PAN
Catalpa *Catalpa* sp.	O_3
Celery *Apium graveolens* L.	O_3, PAN
Cherry *Prunus avium* L.	O_3
Chestnut *Castanea sativa* Mill.	F
Chive *Allium schoenoprasum* L.	PAN
Chrysanthemum *Chrysanthemum* spp.	E, O_3
Cineraria *Cineraria* sp.	O_3
Coleus *Coleus blumei* Benth.	O_3, PAN
Corn *Zea mays* L.	PAN
Cyclamen *Cyclamen* sp.	O_3
Daikon *Raphanus sativus* L. var. *longipinnatus* Bailey	O_3
Dandelion *Taraxacum officinale* Weber	PAN
Endive *Cichorium endivia* L.	PAN
Eucalyptus *Eucalyptus* sp.	O_3

*The plants listed in this table represent only the plants observed during the survey and do not represent all known susceptible plant varieties within the state.

Table 1 (con't.)

PLANT	POLLUTANT
Fern, maidenhair *Adiantum* sp.	O_3, PAN
Fig, common *Ficus carica* L.	O_3
Grapefruit *Citrus maxima* Merr.	O_3
Gladiolus *Gladiolus* sp.	F
Grape *Vitis vinifera* L.	F, O_3
Iris *Iris* sp.	F
Lemon *Citrus limonia* Osbeck	O_3
Lettuce *Lactuca* spp.	PAN
Lilac *Syringa vulgaris* L.	F
Locust, black *Robinia pseudoacacia* L.	O_3
Maple *Acer* spp.	F, O_3
Marjoram *Origanum majorana* L.	O_3
Marigold, pot *Calendula officinalis* L.	O_3, PAN
Mexican tea *Ephedera* sp.	O_3
Mint *Mentha* sp.	O_3
Mock orange *Philadelphus* sp.	O_3
Mulberry *Morus* sp.	O_3
Mustard *Brassica* sp.	PAN
Oak *Quercus* sp.	F, O_3, P
Oat *Avena sativa* L.	PAN
Onion *Allium cepa* L.	O_3
Orange *Citrus sinensis* Osbeck	O_3
Orchid *Cattleya* sp.	E
Palm, Neanthebella *Chamaedorea elegans* Mart.	O_3
Parsley *Petroselinum hortense* Hoffm.	O_3, PAN
Peach *Prunus persica* (L) Batsch	O_3
Pepper *Capsicum annuum* L.	O_3
Petunia *Petunia hybrida* Vilm.	PAN
Philodendron *Philodendron* sp.	O_3, PAN
Pigweed *Amaranthus* sp.	O_3
Pine, yellow *Pinus ponderosa* Dougl.	O_3
Pine, Jeffery *Pinus Jefferyi* Grev. & Balf.	O_3
Pine, Monterey *Pinus radiata* D. Don.	F, O_3
Plum *Prunus* sp.	F

Table 1 (con't.)

PLANT	POLLUTANT
Pothos *Pothos* sp.	O_3, PAN
Radish *Rhaphanus sativus* L.	O_3
Rhododendron *Rhododendron* sp.	O_3
Rhubarb *Rheum rhaponticum* L.	PAN
Rose *Rosa* spp.	E, F
Snapdragon *Antirrhinum majus* L.	O_3
Squash *Cucurbita pepo* L.	PAN
Stock *Matthiola incana* R. Br.	O_3, PAN
Sunflower, common *Helianthus annuus* L.	O_3
Sweetgum *Liquidamber styraciflua* L.	O_3
Sycamore *Platanus* sp.	F, O_3
Tangerine *Citrus reticulata* Blanco	O_3
Tomato *Lycopersicon esculentum* Mill.	O_3, PAN
Tree-of-heaven *Ailanthus altissima* Swingle	O_3
Turnip *Brassica rapa* L.	PAN
Viola *Viola* sp.	O_3
Walnut *Juglans regia* L.	F
Watermelon *Citrullus vulgaris* Schrad.	PAN

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Literature Cited

(1) Air Pollution Control Association. 1970. Recognition of air pollution injury to vegetation: A pictoral atlas. Informative Report No. 1 of the TR-7 Agricultural Committee, Air Pollut. Control Assoc.

(2) California Air Resources Board. 1969. California Air Basins.

(3) Center for Environment Studies, The Pennsylvania State University. 1969. Handbook of effects assessment: Vegetation damage.

(4) Heuer, J. J. 1971. Smog damage to crops in Los Angeles County (unpublished data). Agricultural Services Division, County of Los Angeles, California.

(5) Hindawi, I. J. 1970. Air pollution injury to vegetation. Natl. Air. Pollut. Control Admins. Publication No. AP-71. p. 1-44.

ASSESSMENT OF LOSSES

The purpose of this survey was to determine the extent of air pollution injury to vegetation in California. Such a survey was deemed feasible under the State-County cooperative work relationships for carrying on the State's regulatory agricultural work. The State is made up of 58 counties, 53 of which have an Agricultural Commissioner's office with a staff of agricultural specialists. The survey work was highly dependent upon reports prepared by these county specialists on their observations and evaluations of plant injury in their respective counties. These reports were submitted to the survey leader in Sacramento on a standardized reporting form (see Fig. 3). The form, entitled "Pest and Damage Record - Division of Plant Industry, California Department of Agriculture" was a multi-use form which was prepared for reporting plant pest detection work including air pollution data by both state and county agricultural specialists. The form included "boxes" for recording the host plant, the number of plants, acreage, and crop loss data, as well as other data pertaining to plant pests. A rubber stamp was used to modify the report form so that the type of air pollutant could be more easily recorded.

Observations of air pollution injury made by county specialists were made in conjunction with their other regulatory agriculture duties. The survey leader and assistants also made observations and obtained loss data in areas where county personnel were not available.

Methods of assessing the losses due to air pollution injury and/or damage varied. No specific method can be adequately applied to all the various crops and the situations that exist in California. Since a survey of Los Angeles County has been made since 1966 and because their 1970 survey was already planned and initiated prior to the initiation of this survey, assessment data on Los Angeles County were adapted from their survey report (1).

In instances where there was knowledge of a specific crop planting being abandoned or lost as the result of air pollution, it was assessed as a total loss. With crops, such as citrus and grapes, where experimental research has demonstrated the crop to be less productive as a result of photochemical smog (2,3,4,5), then the assessment estimates were adjusted according to whether the crop was located in an area of mild or severe ambient smog. In the case of citrus in Southern California a 10 to 40% loss was assessed, the percent varying with the areas where the plantings were growing. A 1 to 50% loss was assessed to grapes growing in two counties each in Southern California and in the San Francisco Bay Area. Some figures reported in the cut-flower industry are losses experienced and reported by nurserymen.

When observing and evaluating an occurrence of crop injury, the agricultural specialists strived to obtain information pertinent to loss assessments. In some instances inspections for plant damage were made while obtaining data for the yearly crop report prepared by the individual counties. During the preparation of reports, consideration was given to such factors as, losses due to reduction in yield and in quality, increased costs because of altered cultural practices as a means of alleviating anticipated damage from pollutants, increased labor costs such as the cost of removing injured wrapper leaves of lettuce and the loss of land use.

In absence of available experimental data and actual knowledge for use in assessing losses to some crops, a practical "rule of thumb" was used to evaluate the damage resulting from varying degrees of injury. If visual inspection of the overall leaf surface of the crop plants indicated 1 to 5% of the surface to be injured, then a 1% loss factor was applied for that crop in that particular county. When the leaf surface injury ranged from 6 to 10%, a 2% loss was assessed. If the injury reached 11 to 15% it became

a 4% loss, and 16 to 20% an 8% loss. The losses would increase progressively in this manner along with the increased injury of the leaf surface. The harvest value of crops which was used in determining assessment values was obtained from individual county reports prepared by the Agricultural Commissioners. The crop acreage listed as showing a loss does not necessarily include the total acreage of that crop for the county, but only that acreage for which a percentage loss was computed.

Literature Cited

(1) Heuer, J. J. 1971. Smog damage to crops in Los Angeles County (unpublished). Agricultural Services Division, County of Los Angeles, California.

(2) Thompson, C. R. 1968. Effects of air pollutants on lemons and navel oranges. Calif. Agri. 22(9):2-3.

(3) Thompson, C. R. 1969. Effects of air pollutants in the Los Angeles Basin on citrus. Proc. First International Citrus Symposium 2:705-709.

(4) Thompson, C. R. 1970. Photochemical smog reduced grape yields 60%. Calif. Air Environment 1(5):3.

(5) Thompson, C. R., O. C. Taylor and B. L. Richards. 1970. Effects of photochemical smog on lemons and navel oranges. Calif. Agri. 24(5):11.

ECONOMIC LOSSES

During this 1970 survey to determine the extent of air pollution injury to vegetation in California, it was estimated that the economical losses to agriculture amounted to $25,690,680 (see Table 2). These assessments of loss were computed on agronomic crops only, as no adequate method was developed for assessing native vegetation, forests, and landscape plantings.

Statistical crop reports compiled by individual counties provided data for harvest values. Harvest values are based on season average prices for unprocessed commodities at the first delivery point. Dollar loss reflects only that portion of the crop directly affected. It represents a loss as the result of a reduction in yield as to quantity and/or quality.

Economic losses were determined to occur in 15 counties, Ventura showing the greatest, a loss of $10,723,590. As a group, fruit and nuts experienced the greatest damage showing an assessed loss of $20,273,400 (see Table 3). Citrus accounted for $19,553,400 of this amount and showed the greatest loss of any one commodity. Approximately 96,900 acres of citrus plantings are located in areas of four counties which are subjected to repeated exposures of smog in the Los Angeles air basin. Ventura County has the largest citrus acreage in the Los Angeles air basin thus suffers the greatest economic losses. The assessment of losses to citrus caused by photochemical smog in the Los Angeles air basin is based upon reports of observations (1) and studies conducted in the vicinity of Riverside (2,3,4). The results of the research work (3)

indicate a reduction in fruiting which appears to be a cummulative response in which both a reduced water use and photosynthesis rate plus increased leaf drop all combine to give an impoverished tree which is unable to produce as much fruit as it would in an environment free of plant toxicants.

TABLE 2 SUMMARY OF COUNTIES WITH CROP LOSSES DUE TO AIR POLLUTION IN 1970

County	Estimated Losses
Alameda	$ 37,020
Contra Costa	3,060
Kern	21,290
Los Angeles	2,855,400
Marin	2,756
Monterey	256
Orange	1,598,579
Riverside	5,231,115
San Bernardino	4,610,595
San Diego	1,060
San Joaquin	80
San Mateo	738
Santa Clara	604,890
Santa Cruz	250
Ventura	10,723,590
Total	$25,690,679

TABLE 3 SUMMARY OF 1970 CROP LOSSES IN CALIFORNIA CAUSED BY AIR POLLUTION

CROP	ACREAGE	HARVEST VALUE	DOLLAR LOSS
FRUIT & NUT			
Apricot	40	$ 5,000	$ 5,000
Apple	389	996,000	49,800
Avocado	1,220	1,100,000	31,000
Cherry	21	18,000	1,800
Citrus	96,927	104,368,655	19,553,400
Fig	10	20,000	2,000
Grape	20,914	4,206,230	611,365
Walnut	510	95,500	1,435
Watermelon	40	17,600	17,600
	120,071	110,826,985	20,273,400
FIELD			
Alfalfa	95,314	18,222,180	2,213,880
Barley	27,325	1,474,445	16,505
Bean	15,504	4,642,700	404,805
Corn	2,850	534,000	5,340
Hay, grain	1,200	84,000	1,680
Oats	5,581	1,063,580	10,635
	147,774	26,020,905	2,652,845
VEGETABLE			
Bean	2,280	1,344,000	27,140
Beet	106	112,400	2,770
Celery	5,941	22,632,400	226,325
Chard	50	25,000	5,000
Corn	3,065	2,436,000	106,430
Endive	143	120,700	24,290
Greens	855	990,000	101,000
Lettuce	3,490	3,001,425	63,565
Onion	5,023	4,699,085	118,990
Parsley	5	2,500	25
Radish	625	702,500	36,500
Rhubarb	90	106,000	8,700
Tomato	819	797,700	30,730
Turnip	107	76,660	3,785
Misc.	250	125,000	8,750
	22,849	37,171,370	764,000
NURSERY AND CUT FLOWER			
Bedding plants	23	3,520,000	226,000
Carnation	51	4,811,000	76,260
Carnation	3,312,000*		
Christmas trees	180	100,000	33,500
Chrysanthemum	220	11,112,000	603,500
Chrysanthemum	18,272,000*		
Ground cover	78	2,200,000	80,000
Lawn and sod	95	300,000	9,000

TABLE 3 (con't)

CROP	ACREAGE	HARVEST VALUE	DOLLAR LOSS
NURSERY AND CUT FLOWER (con't)			
Orchid	29	$ 1,048,000	$ 50,110
Orchid	220,000*		
Ornamental	1,525	20,726,000	734,000
Petunia	6	**	2,564
Potted, flower	47	2,500,000	80,000
Potted, foliage	14	1,760,000	47,200
Rose	1	**	200
Vegetable	12	1,040,000	56,000
Misc.	30	60,000	2,100
	2,311	49,177,000	2,000,434
	21,804,000*		
TOTALS	293,005	223,196,260	25,690,679

* House square feet
** Harvest value not available

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Literature Cited

(1) Taylor, O. C. (personal communication).

(2) Thompson, C. R. 1968. Effects of air pollutants on lemons and navel oranges. Calif. Agri. 22(9):2-3.

(3) Thompson, C. R. 1969. Effects of air pollutants in the Los Angeles basin on citrus. Proc. First Internat. Citrus Symposium. 2:705-709.

(4) Thompson, C. R., O. C. Taylor and B. L. Richards. 1970. Effects of photochemical smog on lemons and navel oranges. Calif. Argi. 24(5):11.

AIR POLLUTION DAMAGE TO CALIFORNIA FORESTS

Lake Arrowhead was a beautiful resort area in the San Bernardino National Forest north of San Bernardino in southern California. In the early 1950's the needles of pines, particularly ponderosa and Jeffrey pines, begar to turn chlorotic and drop prematurely. This condition was first called X-disease by Asher (1), who speculated that the disease might be caused by air pollution. In 1963 Parmeter et al. (4), described a similar condition in the San Bernardino Forest and called it chlorotic decline. These authors suggested that this disease might be caused by drought, or air pollution, or both. Later that year, Miller et al. (3), suggested that ozone was the principle cause of chlorotic decline in ponderosa pines. By 1968 Richards et al. (5) determined that X-disease, needle dieback, chlorotic decline, and ozone needle mottle in various pine species are one and the same disease, and proposed that they be called ozone needle mottle.

Aerial surveys in 1969, conducted by the Forest Service and the University of California Statewide Air Pollution Center, Riverside, (7) revealed for the first time the extent of air pollution injury to forests in Southern California. The survey showed that on more than 161,000 acres of ponderosa-Jeffrey pine forest in the San Bernardino National Forest, two-thirds of the trees, an estimated 1.3 million, were damaged by ozone. Three percent were dead, 15 percent were severely affected, and 82 percent were moderately or lightly affected. Damage in the Angeles National Forest, west of Lake Arrowhead, was less extensive because there are fewer ponderosa and Jeffrey pine trees there.

Air pollution injury was observed in Monterey and ponderosa pine stands near Santa Cruz in northern California, and in mixed-conifer forests in the Sierra Nevada east of Fresno in central California. Other forest areas under surveillance for air pollution injury are the Sierra Nevada east of Sacramento, and in San Diego County. The extent of damage has not been evaluated in these areas.

Miller (2) has observed photochemical injury in trees as far as 80 miles east of Los Angeles and suggests that polluted air from Los Angeles is transported into the forested mountain areas. Such a situation is possible in northern and central California, and the potential for severe damage to stands of pine along the entire western slope of the Sierra Nevada facing the Central Valley is indeed great because ponderosa and Jeffrey pine forests are generally denser on the west slope of the Sierra Nevada than anywhere in Southern California. The Department of Interior (6) recently indicated the potential for adverse levels of air pollution in the Sacramento area by assigning to Sacramento an index of 70 (days with oxidant levels above 0.1 ppm) in contrast to the Los Angeles area with an index of 20-30. The Sacramento index is the highest in the nation, and represents a potential problem two to three times greater than the problem now experienced in the Los Angeles area.

Literature Cited

(1) Asher, J. E. 1956. Observations and theory on X-disease or needle dieback. Unpublished report to Arrowhead Ranger District, San Bernardino National Forest.

(2) Miller, P. R. 1969. Air Pollution and the forests of California. Calif. Air Envir. 1(4):1,2,3.

(3) Miller, P. R., J. R. Parmeter, Jr., O. C. Taylor, and E. A. Cardiff. 1963. Ozone injury to the foliage of Pinus Ponderosa. Phytopathology 53:1072-1076.

(4) Parmeter, J. R., Jr., R. V. Bega, and T. Neff. 1963. Chlorotic decline of ponderosa pine in southern California. Plant Dis. Reptr. 46:269-273.

(5) Richards, B. L., Sr., O. C. Taylor and G. F. Edmunds, Jr. 1968. Ozone needle mottle of pine in southern California. J.A.P.C.A. 18(2):73-77. (J. Air Pollut. Contr. Assoc. 18:73-77.)

(6) U.S. Dept. Interior. 1970. Days of high air pollution potential forecast. p. 114. In the National Atlas of the United States of America, Supt. Docs., Washington, D.C. 417 p.

(7) Wert, S. L. 1969. A system for using remote sensing techniques to detect and evaluate air pollution effects on forest stands. Proceed. Sixth Intern. Symp. Remote Sensing of Envir., Univ. Mich., Ann Arbor. Oct. 13-16, 1969. p. 1169-1178.

CONCLUSIONS AND RECOMMENDATIONS

Experiences in observing and evaluating plant injury due to air pollutants and associations with research workers and agricultural specialists directly involved with air pollution problems have provided an acute awareness of the difficulties in evaluating air pollution damage to plants. A feasible method of obtaining reasonable estimates of losses to agricultural crops would be to have the estimates made by workers who are well-trained in the recognition of plant injury and who are thoroughly familiar with cultural practices and marketing values of crops growing in areas where air pollutants may occur. With a uniform system for observing, evaluating and reporting air pollution injury, reliable loss figures could be computed for a relatively large area providing such well-trained observers and evaluators were available. The existing cooperative working relationships of the county departments of agriculture and the California Department of Agriculture provide such a network of agricultural specialists who are conveniently located in the agricultural areas of the state. The survey work reported here was planned to be accomplished mainly through the voluntary participation of these various county agricultural specialists who would make observations for air pollution injury in conjunction with their regular duties. Staff personnel of the Department were available for making observations in other areas where needed.

A plant pathologist, well-trained in the diagnosis and evaluation of air pollution injury on plants, led the survey and coordinated the work with the participating counties. Assistance in conducting the work

on a statewide basis was needed immediately, however, qualified personnel were not readily available for employment because of the temporary nature of the work. Initiation of the grant in June allowed for only 6 months of field observations during 1970 and provided insufficient time to properly coordinate work with counties as their work schedules and budgets for fiscal year 1970-71 had already been planned.

The staff structures vary considerably with each county as does the work assignment of the agricultural specialists in each county. These variations allow for unequal work efforts directed toward air pollution investigations by the participating counties. Those counties having well-recognized air pollution problems tend to have more political and fiscal support for making observations of air pollution plant injury.

More research work is needed to provide reliable data for making more meaningful loss estimates. The suppression of growth and reduction of reproductive structures has been demonstrated to occur without visible expressions of injury as a result of air pollution. Because of available data which shows citrus and grapes to be less productive in ambient smog without visible injury symptoms, better loss estimates were made for these fruit crops. Similar information on other plants is needed so more meaningful loss estimates can be made for other agricultural crops.

Dollar loss values were based on harvest values obtained from individual county crop reports. Because these county crop reports are not normally made available until April, May and June following the calendar report year, an extension beyond the planned termination date of March 23, 1971, was needed for preparing this survey report.

A multi-use form (see Fig. 3) prepared by the Department for trial use in 1970 was used for reporting field observations during the survey. This multi-use form was being developed to minimize report forms needed by State and County plant pest detection workers and to provide a single form from which all field information could be readily transferred to a computer tape for later retrieval. The agriculturists felt the form was confusing and required extra time to fill out. Further use of this form after it has been revised will be needed to determine its usefulness. A smaller, simplified form restricted only to air pollution reporting would have been preferable.

In the planning of future statewide surveys for California it is recommended that for any survey which is to provide data for a calendar year, at least two years should be allowed to provide time for planning, coordinating, conducting and summarizing the work. A lead time of five or six months is needed so the survey leader can coordinate planned work with participating counties and provide group and individual training for agricultural specialists. After the field survey work has been accomplished, six months is needed to summarize and compute the data and to prepare the final report.

Survey work should be conducted during all twelve months of the calendar year. To provide more uniform efforts in survey work by counties, consideration should be given to a monetary-sharing plan for participating counties. With a State-County contractual agreement, financial support could be provided to the counties, thus providing more assurance for work accomplishment.

Appendix 1

AIR POLLUTION CAUSED BY AGRICULTURE

Although this report work has been directed toward air pollution damage to agriculture there is a need for mentioning the role of California agriculture itself in contributing to air pollution. More and more we note the increased vigilance in examining agricultural practices as means of contributing to the overall air pollution problem. As a result of this close scrutiny some of the normally accepted agricultural activities are being found objectionable. In the majority of instances agriculture's contribution to air pollution is affecting man more than plants, and for the most part the objections are generated by the population build-ups in areas that previously were wholly agricultural.

Smoke, dust, odors, hydrocarbons and various pesticides may be emitted into the atmosphere by agricultural activities or during the processing of agricultural or forest products.

Agricultural-associated smoke has been with us for a long time. Burning of grain stubble, controlled burning of rangelands to improve forage for livestock, burning of various fuels for frost protection, and the burning of various crop by-products or wastes such as tree and vine prunings, results in smoke and some hydrocarbons being emitted into the atmosphere.

Dust and odor are associated with the confinement of animals, particularly with dairies and feedlots and with chicken and turkey production. Dust problems also are associated with the cultivation of certain types of light soil, particularly the peat soils of the Sacramento and San Joaquin

river delta areas. With the increased use of commercial fertilizers, dairy and feedlot operators are unable to sell cow manure and must seek economical ways of disposing this odorous by-product that is found objectionable to the populace that continually encroaches upon the once isolated farmer. Dairy operators are continually moving to new locations as a result of this encroachment.

Pesticides used in liquid and dust formulations are applied both from the ground and from the air in various agricultural pest control activities. Although strictly regulated, misapplication of pesticides through errors in judgment can occur and may create pollution problems. Drift of such pesticides as 2,4-D (2,4-dichlorophenoxyacetic acid), DDT (1,1,1-Trichloro-2, 2-bis /P-chlorophenyl/ ethane), and propanil (3,4-dichloropionanilide) (DPA), particularly when applied from aircraft, have resulted in damage to agricultural crops and on occasion led to litigation. Over the past 12 years there has been a chronic problem in one county relative to the foliar effects of 2,4-D on grapes as a result of using this herbicide for weed control in grain crops growing in the vicinity of vineyards. Propanil, a herbicide which effectively controlled watergrass (Echinochloa crusgalli) in rice fields and increased California's rice yield by 14% created a serious propanil problem in prune orchards in seven major rice growing counties (1). Although the foliar effects were evident in mild form during previous years, the symptoms became more severe and widespread in 1967 when the planting of rice was delayed several weeks by spring rains and the growers were forced to compress their applications of propanil into a shorter period and later in the season than usual. Use of propanil is now under strict control.

Although the use of DDT is now limited to four crops in California, improper applications of it in the past has resulted in the contamination of forage or other crops that are grown for use as animal food. There is not only a possible loss to the feed grower as a result of the decreased value of the contaminated feed, but the meat and milk producer who uses the contaminated feed may incur a loss if his meat and milk are rejected because of high levels of DDT.

Objections by the populace to air pollutants related to California agricultural activities has resulted in definite steps to modify some practices to reduce the pollutants or to restrict the time of their occurrence. Burning is regulated in several areas of California to the extent that the burning is permissive only during specific times or during certain meteorological conditions. Research projects in progress to develop more feasible means of reducing air pollutants from agriculture include methods of disposing or incorporating prunings and rice straw into the soil and converting wastes into animal feed or into otherwise useable by-products.

Literature Cited

(1) Barbe, D. G. and J. C. Hillis. 1969. Effects of herbicide propanil on stone fruit trees in California. A report on foliar effects of the herbicide on prune and other stone fruits. Calif. Dept. of Agri. Special publication No. 69-1.

APPENDIX

TABLE 4 COUNTY CROP LOSSES

CROP	ACREAGE AFFECTED	HARVEST VALUE	YIELD REDUCTION	DOLLAR LOSSES
ALAMEDA				
FIELD				
Alfalfa	1,650	$ 251,000	1%	$ 2,510
FRUIT AND NUT				
Apricot	40	5,000	100%	5,000
Grape	1,750	572,000	1%	5,720
Walnut	10	2,000	25%	500
VEGETABLE				
Bean, green	500	186,000	1%	1,860
Corn, sweet	780	413,000	1%	4,130
NURSERY AND CUT FLOWERS				
Orchid	222,000 HSF*	148,000	10%	14,800
Petunia	5	**	-	2,500***
TOTALS	4,735 & 222,000 HSF*	$1,570,000	-	$37,020

****

CONTRA COSTA				
FRUIT AND NUT				
Grape	1,218	192,360	1%	1,925
Walnut	500	93,500	1%	935
NURSERY AND CUT FLOWERS				
Rose	1	**	-	200***
TOTALS	1,719	285,860	-	3,060

*HSF - House Square Feet
**Harvest value not made available
***Loss value reported by nursery

TABLE 4 (con't)

CROP	ACREAGE AFFECTED	HARVEST VALUE	YIELD REDUCTION	DOLLAR LOSSES
KERN				
FIELD				
Alfalfa	6,664	$ 1,349,460	1%	$ 13,495
VEGETABLE				
Lettuce	1,064	779,625	1%	7,795
TOTALS	7,728	1,128,085	-	21,290
		**********		
LOS ANGELES				
FRUIT AND NUT	4,781	4,320,000	-	893,000
FIELD	34,165	6,512,000	-	143,150
VEGETABLE	5,090	6,235,000	-	377,450
NURSERY AND CUT FLOWERS	2,185	35,285,000	-	1,441,800
TOTALS	46,221	52,352,000	-	2,855,400
		**********		
MARIN				
NURSERY AND CUT FLOWERS				
Orchid	1	**	-	2,756***
TOTALS	1		-	2,756
		**********		
MONTEREY				
NURSERY AND CUT FLOWERS				
Orchid	1	**	-	256***
TOTALS	1		-	256

TABLE 4 (con't)

CROP	ACREAGE AFFECTED	HARVEST VALUE	YIELD REDUCTION	DOLLAR LOSSES
ORANGE				
FIELD				
Bean	3,709	$ 849,500	3%	$ 25,485
FRUIT AND NUT				
Grapefruit	208	194,400	20%	38,880
Lemon	952	594,400	25%	148,600
Orange, navel	241	70,400	20%	14,080
Orange, valencia	16,473	6,754,600	20%	1,350,920
VEGETABLE				
Bean	600	685,000	3%	20,550
NURSERY AND CUT FLOWERS				
Petunia	1	**	-	64***
TOTALS	22,184	9,148,300	-	1,598,579

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RIVERSIDE				
FIELD				
Alfalfa	39,005	6,775,520	20%	1,355,105
Barley	21,825	1,222,545	1%	12,225
Oat	5,581	1,063,580	1%	10,635
FRUIT AND NUT				
Grapefruit	1,191	1,745,620	35%	610,965
Grape	1,411	14,670	50%	7,320
Lemon	1,679	2,662,570	40%	1,065,030
Misc. citrus	137	31,630	35%	11,070
Orange, navel	5,101	3,587,325	35%	1,255,565
Tangerine	119	41,560	35%	14,545
Orange, valencia	3,914	2,393,650	35%	837,770
Watermelon	40	17,600	100%	17,600
VEGETABLE				
Celery	1	2,400	1%	25
Endive	3	3,000	25%	750
Onion	4,423	2,899,085	1%	28,990
Parsley	5	2,500	1%	25
Tomato	659	345,800	1%	3,460
Turnip	7	1,660	2%	35
TOTALS	85,101	22,810,685	-	5,231,115

TABLE 4 (con't)

CROP	ACREAGE AFFECTED	HARVEST VALUE	YIELD REDUCTION	DOLLAR LOSSES
SAN BERNARDINO				
FIELD				
Alfalfa	19,000	$3,520,000	20%	$ 704,000
Barley	1,000	75,900	1%	760
Bean, blackeye	325	43,200	10%	4,320
Corn, sweet	2,850	534,000	1%	5,340
FRUIT AND NUT				
Apple	389	996,000	5%	49,800
Cherry	21	18,000	10%	1,800
Grape	13,932	1,147,200	50%	573,600
Grapefruit	1,492	1,069,200	35%	374,220
Lemon	2,682	2,010,000	40%	804,000
Orange, navel	8,655	3,116,000	35%	1,090,600
Orange, valencia	5,110	2,681,000	35%	938,350
Orange, misc.	436	100,300	35%	35,105
VEGETABLE				
Beet, table	36	48,400	2%	970
Endive	70	78,000	20%	15,600
Lettuce, leaf	106	93,800	10%	9,380
Radish	25	27,500	10%	2,750
TOTALS	56,129	15,558,500	-	4,610,595

****

SAN DIEGO				
NURSERY AND CUT FLOWERS				
Chrysanthemum	5	100,000	1%	1,000
Orchid	1	**	-	60***
TOTALS	6	100,000	-	1,060

****

SAN JOAQUIN				
FIELD				
Alfalfa	80		-	80
TOTALS	80		-	80

TABLE 4 (con't)

CROP	ACREAGE AFFECTED	HARVEST VALUE	YIELD REDUCTION	DOLLAR LOSSES
SAN MATEO				
NURSERY AND CUT FLOWERS				
Orchid	2	$ **	-	$ 738***
TOTALS	2		-	738
		**********		
SANTA CLARA				
FIELD				
Alfalfa	450	74,200	1%	740
FRUIT AND NUT				
Grape	2,603	2,280,000	1%	22,800
VEGETABLE				
Bean, fresh, processed lima and snap	1,180	473,000	1%	4,730
Endive	70	39,700	20%	7,940
Lettuce, Romaine	200	123,000	10%	12,300
Tomato	100	255,900	8%	20,470
NURSERY AND CUT FLOWERS				
Carnation	3,312,000 HFS*	3,591,000	1%	35,910
Chrysanthemum	103 & 18,272,000 HFS*	10,012,000	5%	500,000
TOTALS	4,706 & 21,584,000 HFS*	16,848,000	-	604,890
		**********		
SANTA CRUZ				
NURSERY AND CUT FLOWERS				
Carnation	5	**	-	250***
TOTALS	5		-	250

TABLE 4 (con't)

CROP	ACREAGE AFFECTED	HARVEST VALUE	YIELD REDUCTION	DOLLAR LOSSES
VENTURA				
FIELD				
Bean	11,470	$ 3,750,000	10%	$ 375,000
FRUIT AND NUTS				
Grapefruit	776	1,510,000	10%	151,000
Lemon	23,380	53,842,000	15%	8,076,300
Orange, navel	2,000	2,328,000	10%	232,800
Orange, valencia	18,830	16,436,000	10%	1,643,600
VEGETABLE				
Celery	5,940	22,630,000	1%	226,300
Lettuce, Romaine	1,990	1,849,000	1%	18,490
NURSERY AND CUT FLOWERS				
Carnation	1	**	-	100***
TOTALS	63,387	102,345,000	-	10,723,590

TABLE 5 SUMMARY OF COUNTY PLANT INJURY REPORTS

FOOD CROP	POLLUTANT*	REPORTS	FLORAL AND WEED CROP	POLLUTANT	REPORTS	FOREST & SHADE	POLLUTANT	REPORTS
ALAMEDA								
Alfalfa	O_3	2	Gladiolus	F	4	Chestnut	F	1
Apricot	F	6	Iris	F	1	Maple	F	2
Bean	O_3	2	Orchid	E	7	Oak	F	1
Corn	F	2	Petunia	PAN	5	Pine	F	2
Grape	F	1	Rose	F	2	Pine	O_3	8
Grape	O_3	8				Sweetgum	F	1
Plum	F	2				Sycamore	O_3	1
Tangerine	F	1						
Walnut	F	5						
		29			19			16
							Total County Reports	64
AMADOR								
Walnut	F	1				Tree-of-heaven	F	1
						Pine	O_3	1
						Boxelder	F	1
		1						3
							Total County Reports	4
CONTRA COSTA								
Grape	SO_2	3	Gladiolus	F	2	Pine	F	1
Walnut	SO_2	2	Rose	F	2			
		5			4			1
							Total County Reports	10

*E = Ethylene
F = Fluoride
O_3= Ozone
PAN = Peroxyacyl nitrate
P = Particulate
SO_2 = Sulfur dioxide

TABLE 5 (con't)

FOOD CROP	POLLUTANT	REPORTS	FLORAL AND WEED CROP	POLLUTANT	REPORTS	FOREST & SHADE	POLLUTANT	REPORTS
EL DORADO								
Forage	P	1				Oak	P	1
						Pine	O_3	$\frac{1}{2}$
		1						
						Total County Reports		3
FRESNO								
Corn	O_3	1				Pine	O_3	2
						Sycamore	O_3	$\frac{1}{3}$
		1						
						Total County Reports		4
KERN								
Alfalfa	PAN	1						
Lettuce, Romaine	PAN	$\frac{1}{2}$						
						Total County Reports		2
LOS ANGELES								
Alfalfa	O_3	1	Aster	PAN	1	Boxelder	O_3	1
Avocado	O_3	1	Azalea	SO_2	2	Catalpa	O_3	2
Barley	PAN	1	Burmuda Sod	PAN	2	Eucalyptus	O_3	1
Chive	PAN	1	Calceolaria	O_3	1	Palm	O_3	2
Corn	PAN	7	Carnation	E	1	Pine	O_3	3
Daikon	O_3	2	Carnation	PAN	1	Sweetgum	O_3	2
Dandelion	PAN	2	Chrysanthemum	O_3	5	Sycamore	O_3	4
Fig	O_3	3	Cineraria	O_3	1			
Lemon	O_3, PAN	2	Coleus	O_3, PAN	1			
Lettuce, butterhead	PAN	1	Cyclamen	O_3	1			

TABLE 5 (con't)

FOOD CROP	POLLUTANT	REPORTS
LOS ANGELES (con't)		
Marjoram	O_3	2
Mint	O_3	2
Mustard	PAN	1
Onion	O_3	3
Parsley	PAN	1
Peach	O_3	1
Pepper	O_3	1
Radish	O_3	1
Rhubarb	PAN	2
Squash	PAN	1
Tomato	O_3	3
Turnip	PAN	2
		41
MARIN		
MONTEREY		
Bean	F	1
ORANGE		
Bean	O_3	2
Bean	PAN	1
		3
PLACER		
Grape	F	1

FLORAL AND WEED CROP	POLLUTANT	REPORTS
Fern, maidenhair	O_3, PAN	1
Marigold, pot	O_3, PAN	1
Orchid	E	7
Petunia	PAN	3
Philodendron	O_3, PAN	1
Pothos	O_3, PAN	1
Rhododendron	O_3	2
Salome	O_3, PAN	1
Snapdragon	O_3	1
Stock	O_3, PAN	1
Viola	O_3	1
		36
Orchid	E	12
Orchid	E	2
Petunia	PAN	1
		1
Rose	F	1

FOREST & SHADE	POLLUTANT	REPORTS
		15
Total County Reports		92
Total County Reports		12
Total County Reports		3
Total County Reports		4
Sycamore	F	1
Total County Reports		3

TABLE 5 (con't)

FOOD CROP	POLLUTANT	REPORTS
RIVERSIDE		
Alfalfa	O_3	6
Barley	PAN	1
Celery	PAN	1
Cherry	O_3	1
Daikon	O_3	1
Endive	PAN	2
Grape	O_3	3
Oat	PAN	4
Onion	O_3	2
Parsley	O_3	1
Radish	PAN	3
Tomato	PAN	1
Turnip	PAN	1
Watermelon	PAN	1
		28
SAN BERNARDINO		
Alfalfa	PAN	2
Alfalfa	O_3	7
Apple	O_3	1
Barley	PAN	2
Bean	O_3	1
Beet	PAN	4
Celery	PAN	2
Cherry	O_3	1
Corn	PAN	2
Endive	PAN	2
Grape	O_3	8
Lettuce	PAN	3
Radish	O_3	4
Sunflower	O_3	1
		40

FLORAL AND WEED CROP	POLLUTANT	REPORTS
Mexican tea	O_3	1
Mock Orange	O_3	1
Pigweed	O_3	1
		3

FOREST & SHADE	POLLUTANT	REPORTS
Bottlebrush	O_3	1
Catalpa	O_3	1
Locust	O_3	1
Mulberry	O_3	1
Pine	O_3	3
Sycamore	O_3	2
		9

Total County Reports 37

Boxelder	O_3	1
Catalpa	O_3	1
Maple	O_3	1
Mulberry	O_3	4
Oak	O_3	2
Pine	O_3	4
Sycamore	O_3	2
Tree-of-heaven	O_3	1
		16

Total County Reports 59

TABLE 5 (con't)

FOOD CROP	POLLUTANT	REPORTS	FLORAL AND WEED CROP	POLLUTANT	REPORTS	FOREST & SHADE	POLLUTANT	REPORTS
SAN DIEGO								
			Chrysanthemum	O_3	1			
			Orchid	E	1			
			Pigweed	O_3	1			
			Lettuce, wild	O_3	1/4			
							Total County Reports	4
SAN JOAQUIN								
Alfalfa	O_3	1						
							Total County Reports	1
SAN MATEO								
			Orchid	E	22			
							Total County Reports	22
SANTA CLARA								
Alfalfa	O_3	1	Carnation	O_3	2	Pine	F	1
Apricot	F	1	Chrysanthemum	O_3	2	Pine	O_3	7
Bean	O_3	2	Petunia	PAN	1	Sycamore	O_3	1
Endive	PAN	3	Rose	E	1			
Grape	O_3	2						
Lettuce	PAN	3						
Tomato	PAN	1						
Walnut	F	1						
		14			6			9
							Total County Reports	29
SANTA CRUZ								
			Carnation	E	5			
			Chrysanthemum	E	1			
					6			
							Total County Reports	6

TABLE 5 (con't)

FOOD CROP	POLLUTANT	REPORTS	FLORAL AND WEED CROP	POLLUTANT	REPORTS	FOREST & SHADE	POLLUTANT	REPORTS
SOLANO								
			Gladiolus	F	1			
						Total County Reports		1
SUTTER								
			Lilac	F	1	Ash	F	1
			Rose	F	1	Pine	F	1
						Sycamore	F	1
					2			3
						Total County Reports		5
TULARE								
						Pine	O_3	1
						Total County Reports		1
VENTURA								
Bean	O_3	11				Pine	O_3	2
Celery	O_3	1						
Lettuce	PAN	1						2
		13				**Total County Reports**		15
						Grand Total		381

O R E G O N
P A C I F I C
N E V A D A
A R I Z O N A
M E X I C O
Lake Tahoe
San Francisco
Bay
San Joaquin Valley
North Central Coast
South Central Coast
San Diego

NOT REPRODUCIBLE

Fig. 1
Eleven air basins defined by the California Air Resources Board.

1. Crescent City Basin
2. Tulelake Basin
3. Suprise Valley Basin
4. Eureka Basin
5. Redding Basin
6. Honey Lake Basin
7. Ukiah Basin
8. Sacramento Valley Basin
9. Lake Tahoe Basin
10. San Francisco Bay Area Basin
11. San Joaquin Valley Basin
12. Mono Lake Basin
13. Salinas Valley Basin
14. Owens Valley Basin
15. San Luis Obispo Basin
16. Santa Maria Basin
17. Antelope Valley Basin
18. Los Angeles Basin
19. Imperial-Coachella Basin

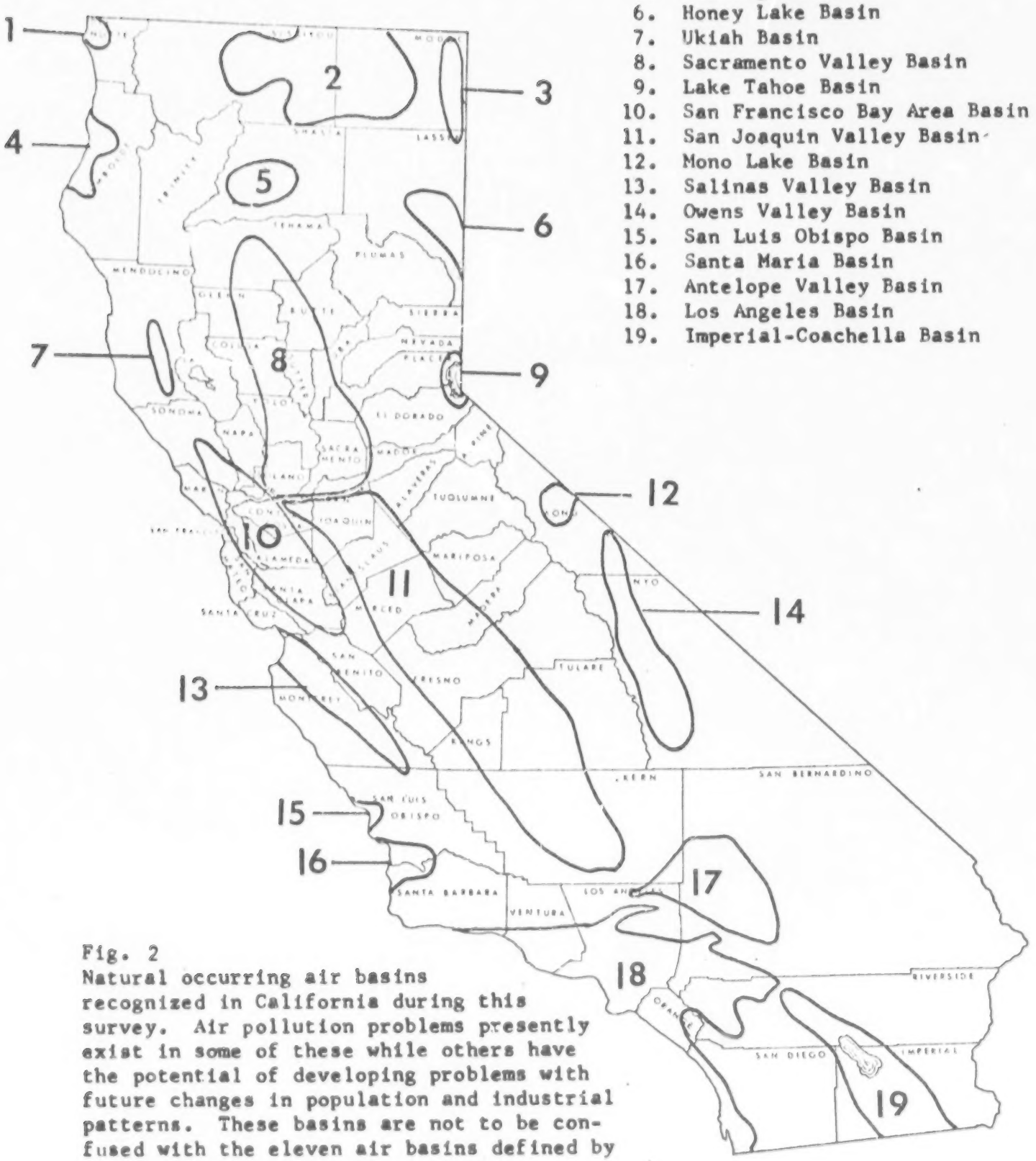

Fig. 2
Natural occurring air basins recognized in California during this survey. Air pollution problems presently exist in some of these while others have the potential of developing problems with future changes in population and industrial patterns. These basins are not to be confused with the eleven air basins defined by the California Air Resources Boar

PEST AND DAMAGE RECORD - DIVISION OF PLANT INDUSTRY

CALIFORNIA DEPARTMENT OF AGRICULTURE

No. 1381

Activity	County	Section	Township	Range	Base & Meridian	Date (seen or collected)

Host/Crop | Host/Crop

Situation | No. of Plants | Net — Acres — Gross | Origin — Quarantine — Destination

Pest/Pathogen/Condition | Pest/Pathogen/Condition | Identifier

Owner

Address

Location

Collector | Affiliation (F S C E U O)

Crop Loss

Damage % of Plant | Type of Loss: Quality / Quantity | Control Cost/A

% of Plants | % of Marketable Crop | New / Additional / Replacement

Entomology

Stage: E L P N A | Condition: A D Trap

Specimen Count: Leaf | Stem | Limb

Sweep | Sq. Yd. | Lin. ft.

Animal | Trap | Other

Weeds

Distribution: limited / scattered / widespread / eradicated

Density: light / medium / heavy

Plant Symptoms

Plants L S G: Wilting, Sudden collapse, Slow decline, Yellowing, Dieback, Leaf fall, Leaf spot, Shot hole, Marginal burn, Leaf mottling, Canker, Rough bark, Root rot, Fruit rot, Fruit spot, Galls, Internal discoloration, Stunting, Malformation, Gumming

Plant Parts

Symptoms L S G: Leaves, upper surface; Leaves, lower surface; Petioles; Terminal branches; Large branches; Trunk or main stem; Large roots; Rootlets; Bulbs or corms; Tubers; Buds; Blossoms; Fruits or nuts; Seeds; Bark; Growing tip

Determination: Date | By

FIELD DIAGNOSIS: / Kind of Insect / REMARKS

AIR POLLUTANT

☐ O_3 ☐ SO_2

☐ PAN ☐ ETHYLENE

☐ HF ☐ OTHERS

Send Report To:

No. 1381

Activity

Plant Quarantine

00 Border Stations
02 Maritime - Foreign
03 Maritime - Domestic
04 Aircraft - Foreign
05 Aircraft - Domestic
07 Terminal (Postal, truck, rail)

Entomology

10 General
16 Grape Leaf Skeletonizer
17 Pink Bollworm
20 Urban Grid Survey
25 Fruit Fly Survey

Plant Pathology

40 General
55 Nematology
60 Weed and Vertebrate Pest Control

Crop Loss Reporting

90 Air Pollution

County

01 Alameda
02 Alpine
03 Amador
04 Butte
05 Calaveras
06 Colusa
07 Contra Costa
08 Del Norte
09 El Dorado
10 Fresno
11 Glenn
12 Humboldt
13 Imperial
14 Inyo
15 Kern
16 Kings
17 Lake
18 Lassen
19 Los Angeles
20 Madera
21 Marin
22 Mariposa
23 Mendocino
24 Merced
25 Modoc
26 Mono
27 Monterey
28 Napa
29 Nevada
30 Orange
31 Placer
32 Plumas
33 Riverside
34 Sacramento
35 San Benito
36 San Bernardino
37 San Diego
38 San Francisco
39 San Joaquin
40 San Luis Obispo
41 San Mateo
42 Santa Barbara
43 Santa Clara
44 Santa Cruz
45 Shasta
46 Sierra
47 Siskiyou
48 Solano
49 Sonoma
50 Stanislaus
51 Sutter
52 Tehama
53 Trinity
54 Tulare
55 Tuolumne
56 Ventura
57 Yolo
58 Yuba

Counties Adjacent to California

61 Mohave Co., Arizona
62 Yuma Col, Arizona

71 Clark Co., Nevada
72 Douglas Co., Nevada
73 Esmeralda Co., Nevada
74 Lyon Co., Nevada
75 Mineral Co., Nevada
76 Nye Co., Nevada
77 Ormsby Co., Nevada
78 Washoe Co., Nevada

81 Curry Co., Oregon
82 Jackson Co., Oregon
83 Josephine Co., Oregon
84 Klamath Co., Oregon
85 Lake Co., Oregon

Situation

01 Interstate quarantine
02 Intrastate quarantine
03 Campers
04 Trailers
05 Busses
06 Trucks
07 Container or B & B Nursery stock
08 Nursery growing ground
09 Greenhouse
10 Field crop
11 Orchard
12 Small grain
13 Turf
14 Irrigated pasture
15 Rangeland
16 Ornamental planting; parks and recreation areas
17 Forest
18 Roadside, highway edge
19 Waste ground, fencerow
20 Home garden, urban residence
21 Flowing water; stream bank, ditch bank
22 Still water: pond or lake

Rev. 30 June 1970

(Reverse side of report form showing codes used in preparing front of report.)

Fig. 3. Report form used by the California Department of Agriculture.

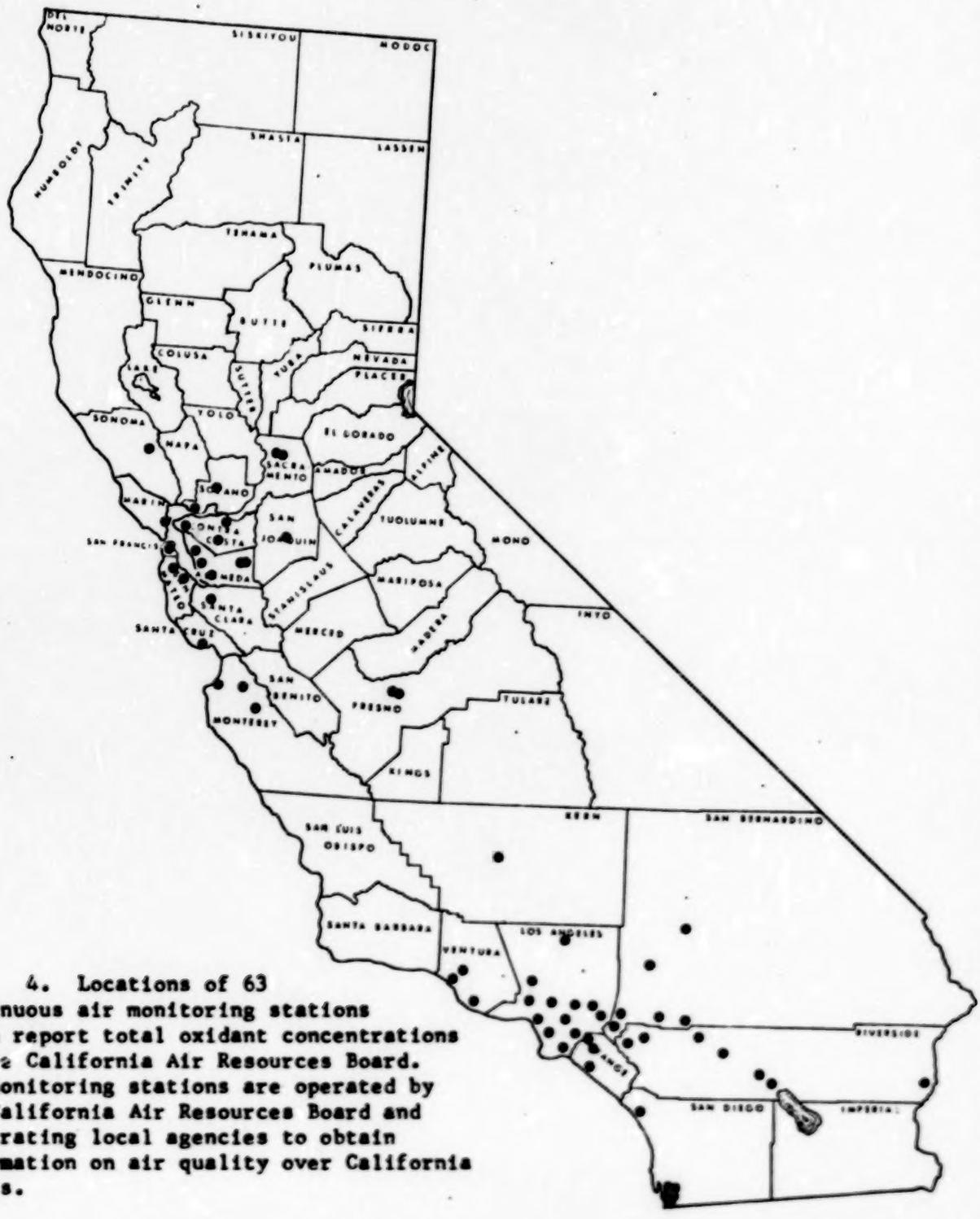

Fig. 4. Locations of 63 continuous air monitoring stations which report total oxidant concentrations to the California Air Resources Board. Air monitoring stations are operated by the California Air Resources Board and cooperating local agencies to obtain information on air quality over California cities.